Artificial Intelligence

Recurrent Neural Network

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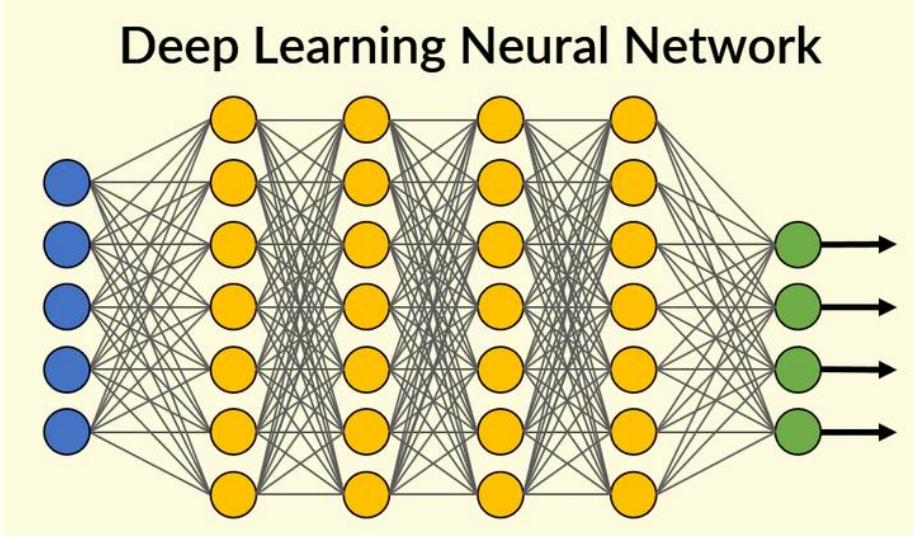
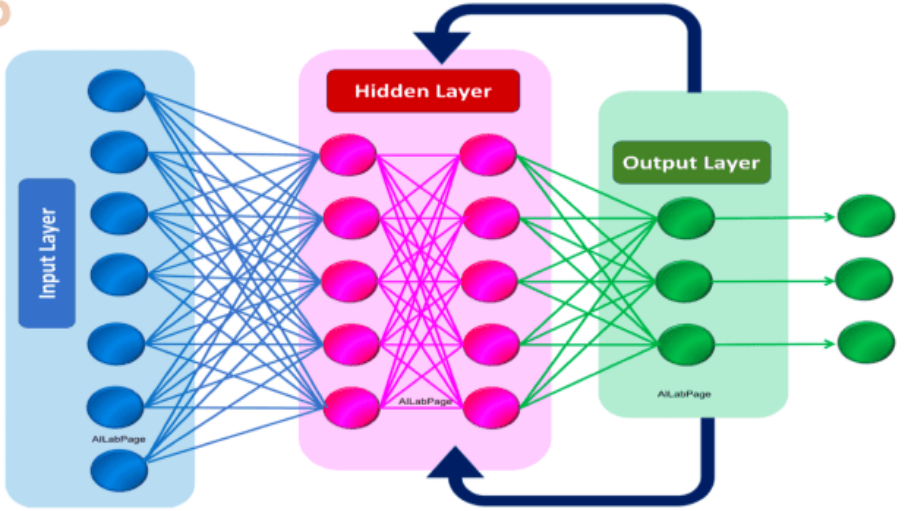
Recurrent Neural Network

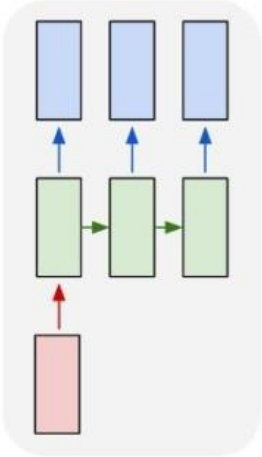
- Feedforward neural network
  - Information moves in one direction
  - No feedback
  - No memory of the input
  - Bad at predicting what's coming next
- Recurrent neural network
  - Human brain is a RNN
  - Information cycles through a loop
  - Considers current input and what has been learned
  - Has a short-term memory
  - Sequence of data contains crucial information about what is coming next





Recurrent Neural Network

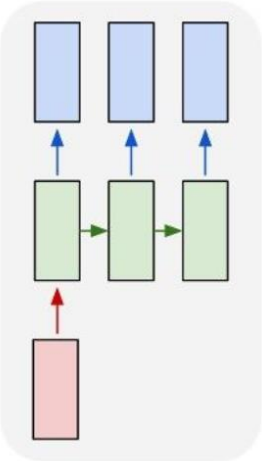
one to many



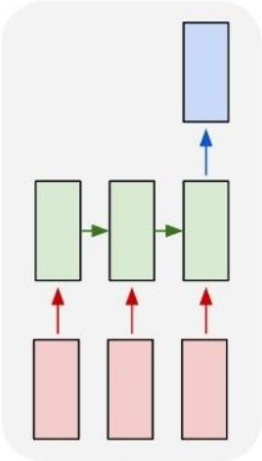
e.g. **Image Captioning**
image -> sequence of words

Recurrent Neural Network

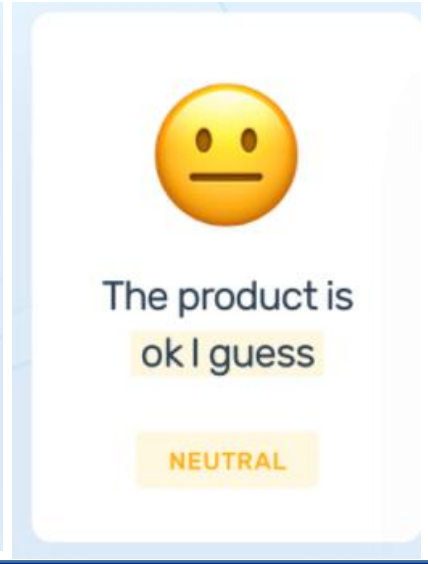
one to many

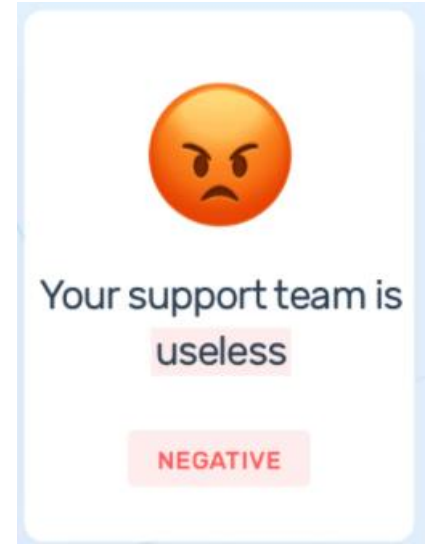


many to one

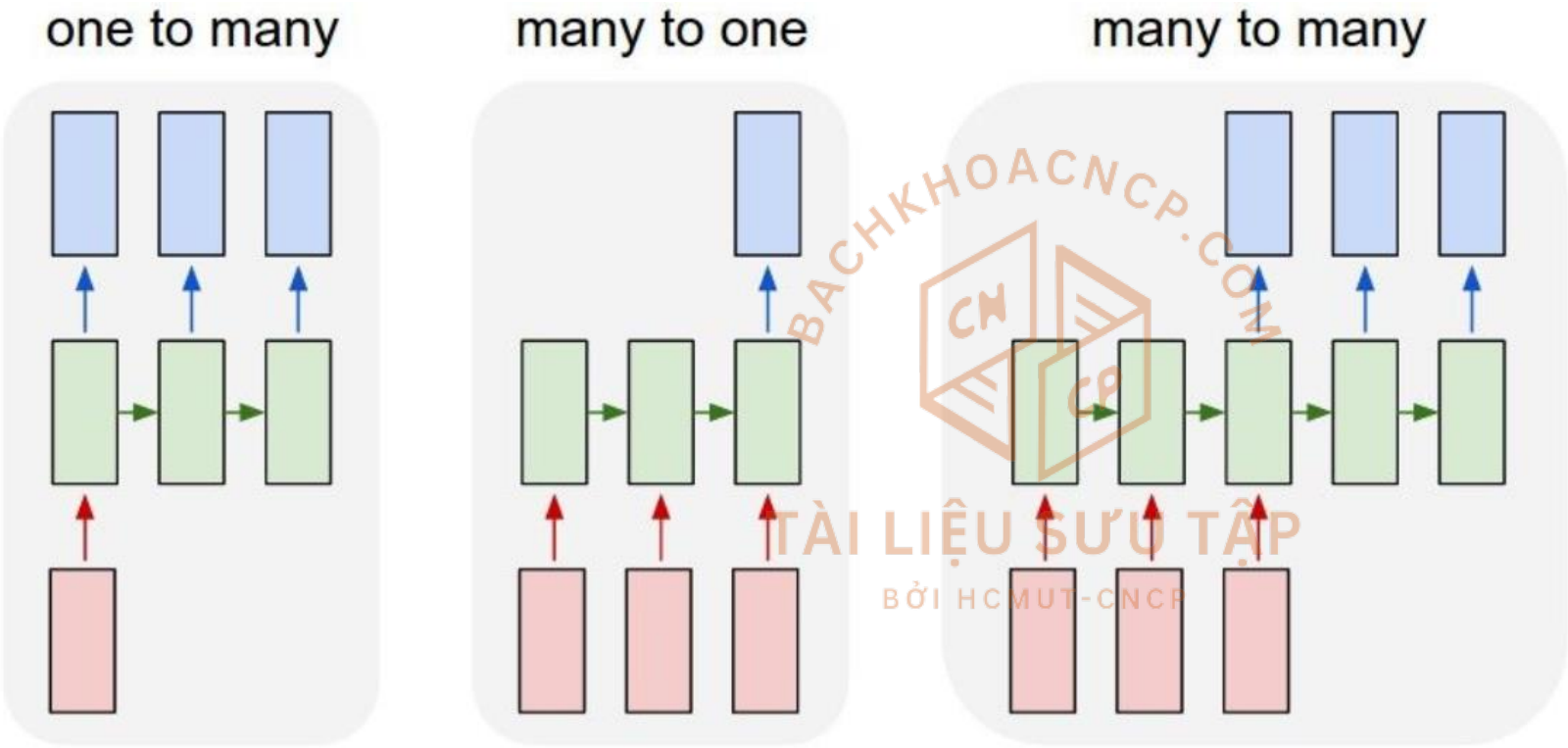


e.g. **Sentiment Classification**
sequence of words -> sentiment



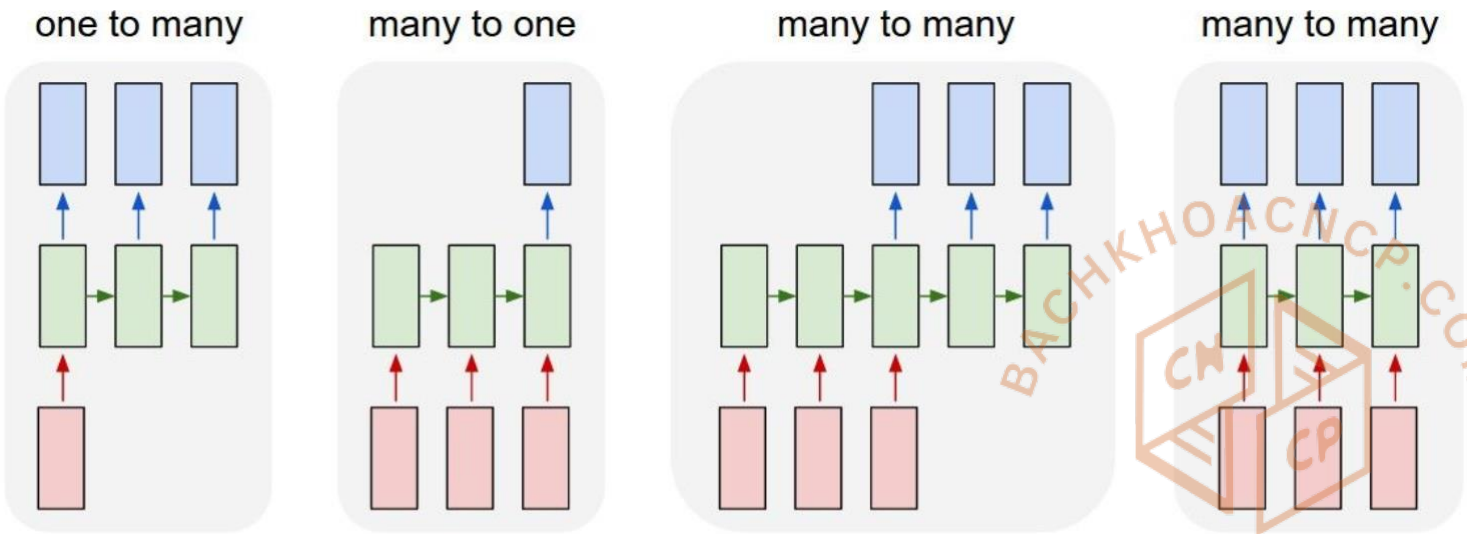


Recurrent Neural Network

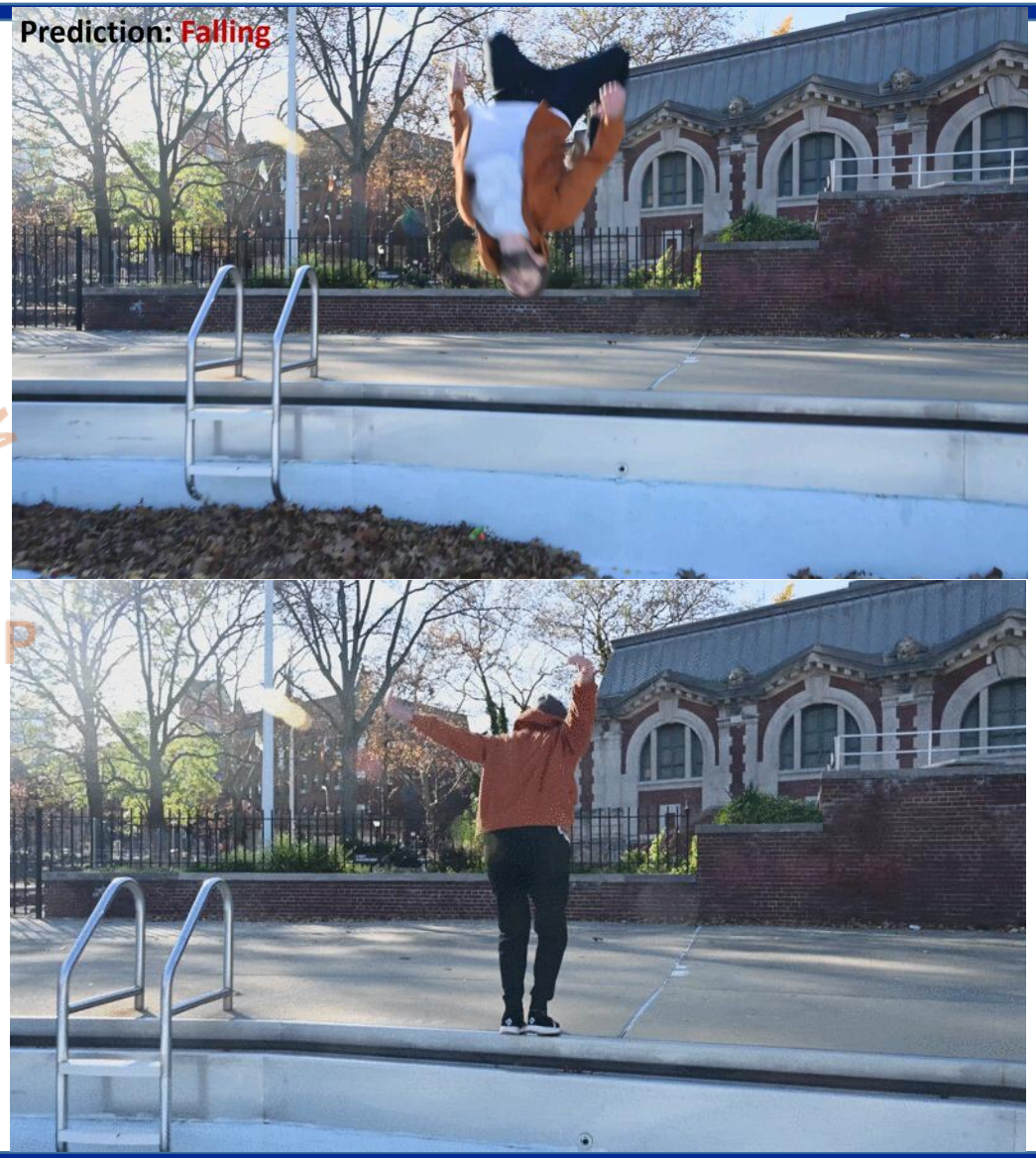


e.g. **Machine Translation**
seq of words -> seq of words

Recurrent Neural Network

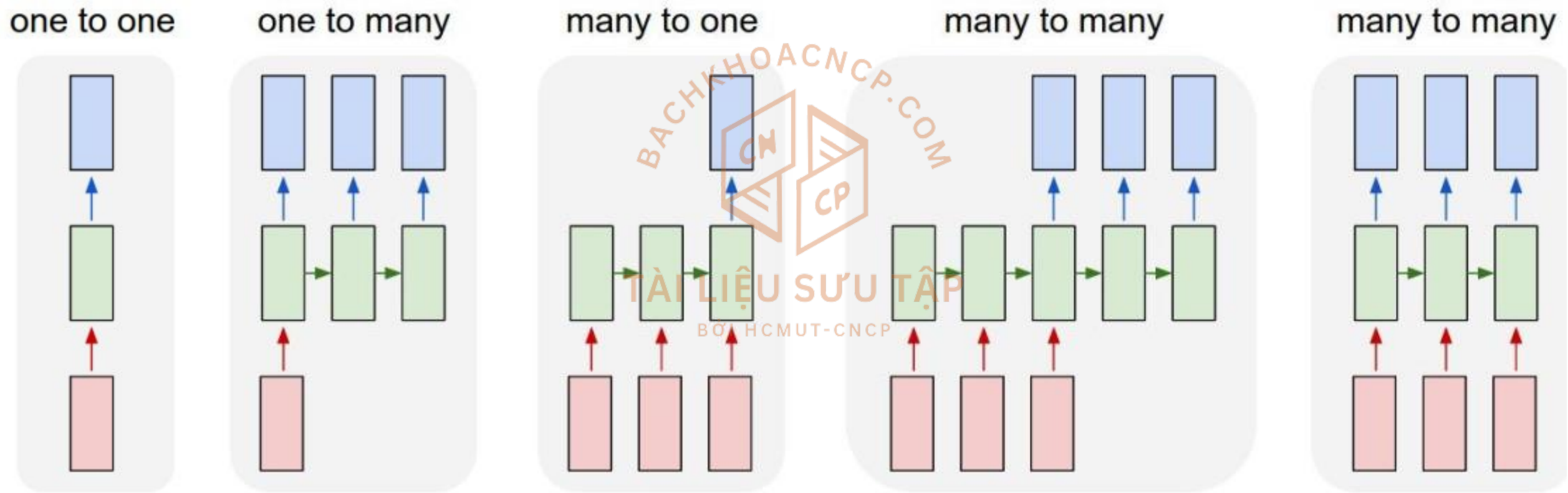


e.g. **Video classification on frame level**



A person doing a backflip

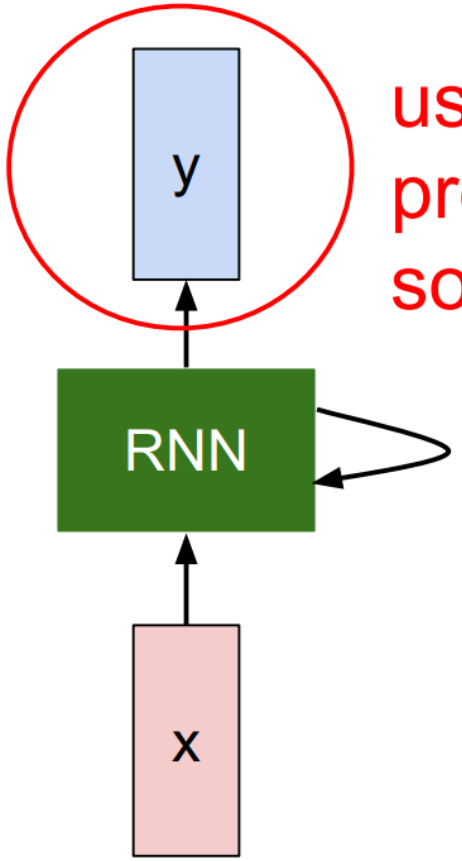
Recurrent Neural Network



Recurrent Neural Network

- When to use a RNN?
  - Sequence of data, and
  - Temporal dynamics connecting the data is more important than spatial content of each individual frame

Recurrent Neural Network



usually want to predict a vector at some time steps

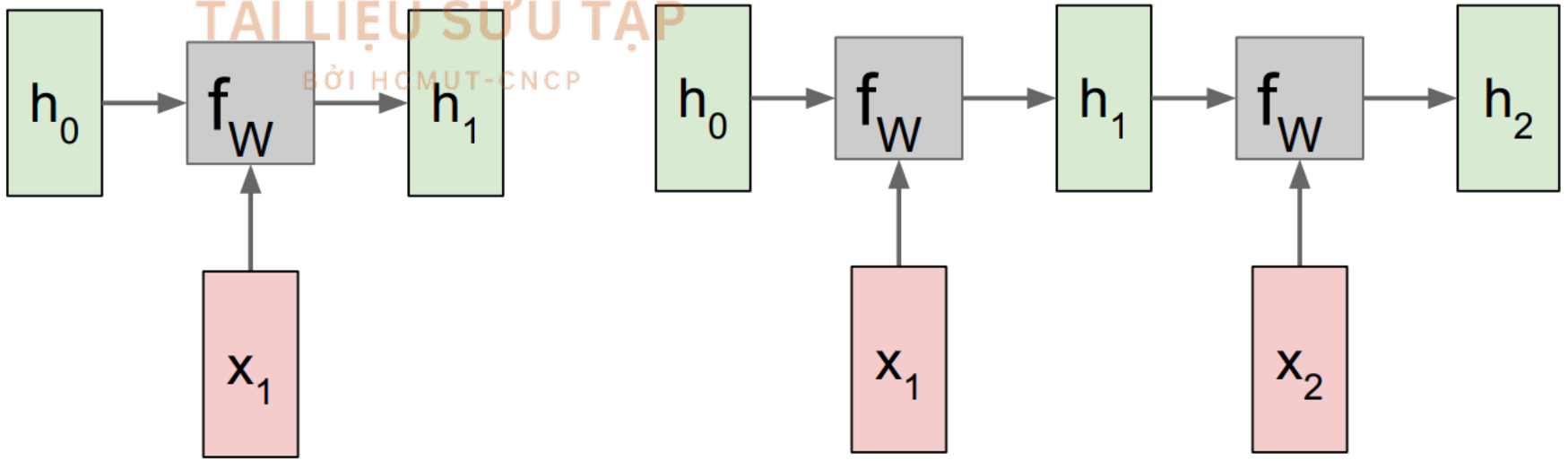
$$h_t = f_W(h_{t-1}, x_t)$$

new state

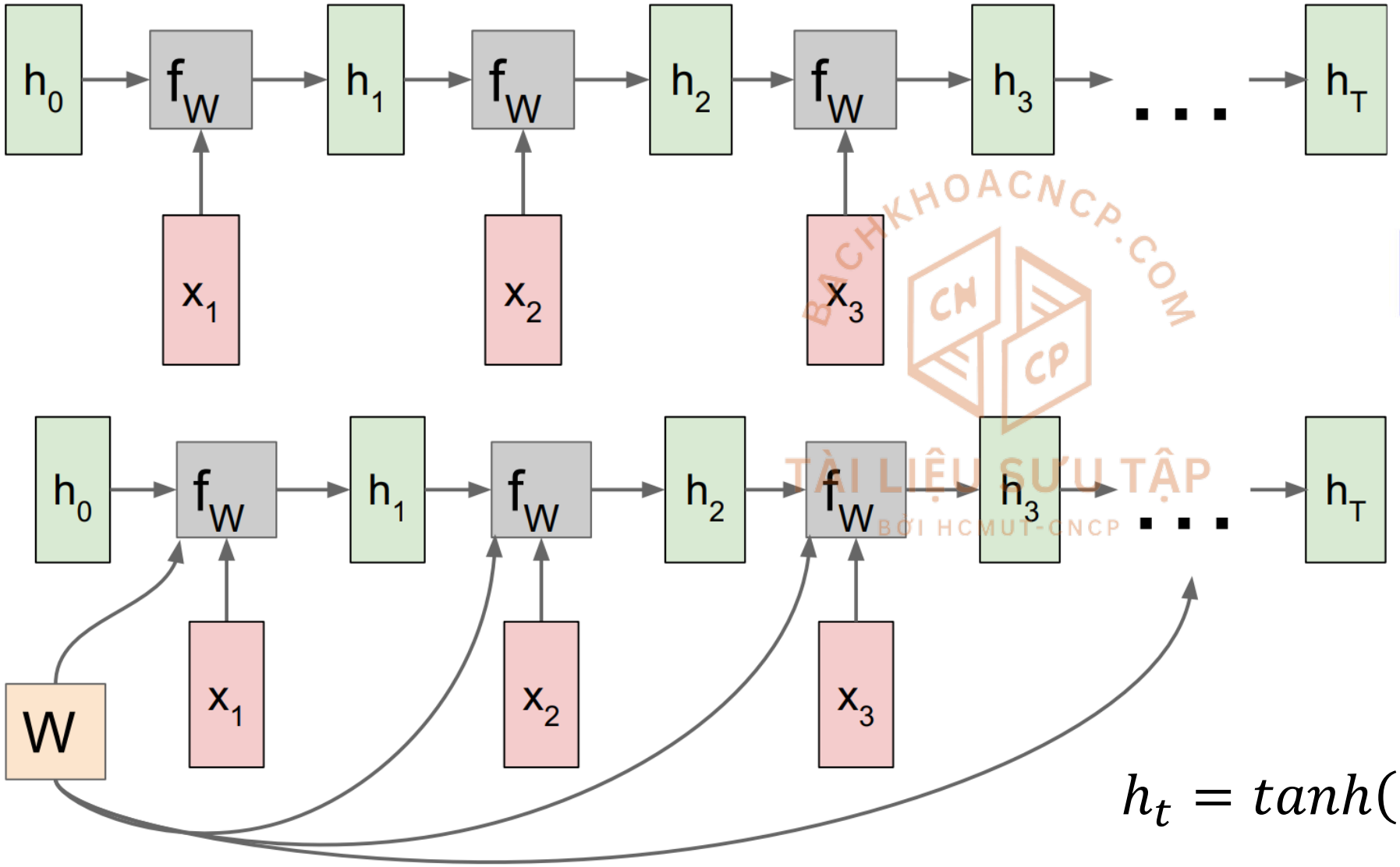
some function with parameters W

old state

input vector at some time step



Recurrent Neural Network



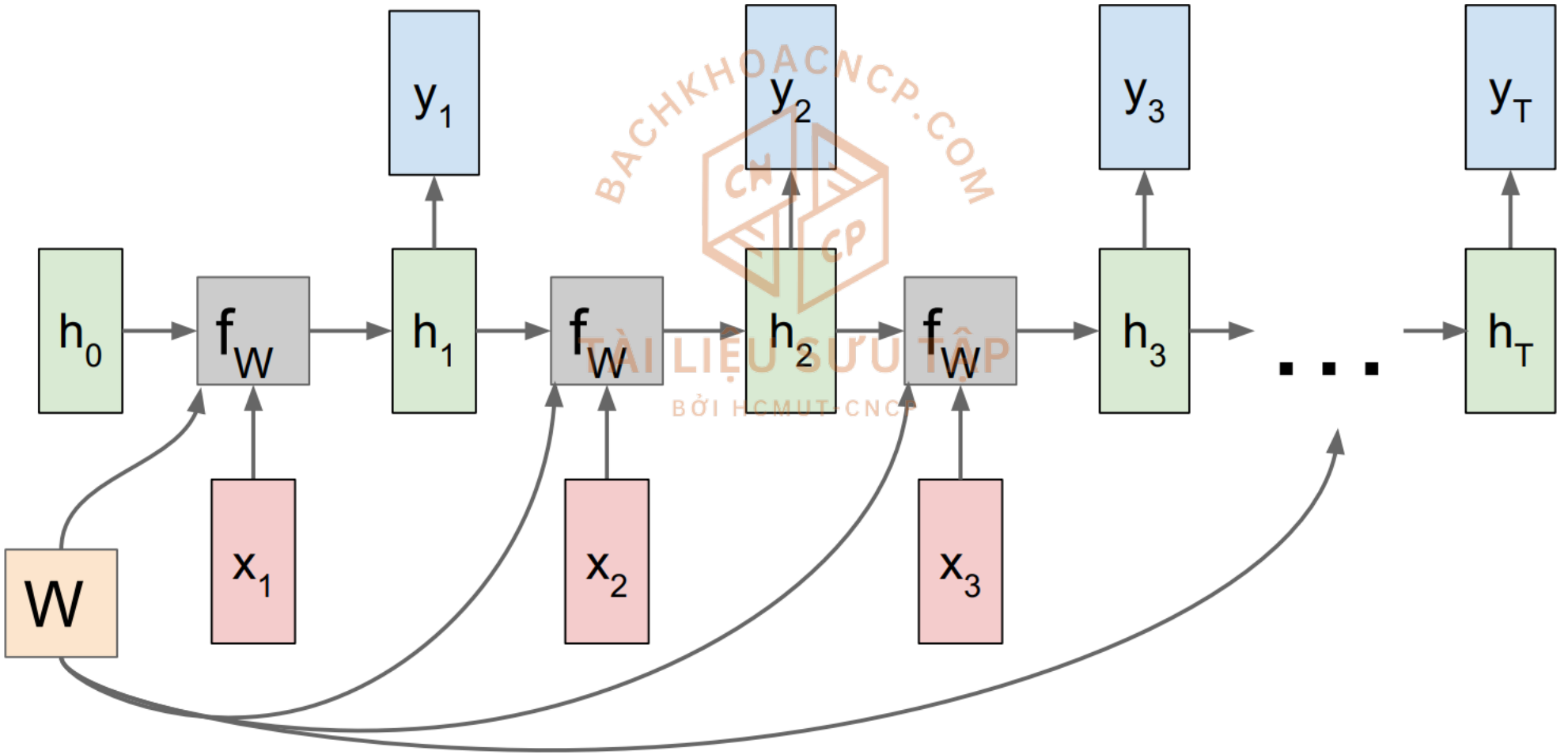
$$h_t = f_W(h_{t-1}, x_t)$$

$$\begin{bmatrix} W_{hh} & 0 \\ 0 & W_{xh} \end{bmatrix} \begin{bmatrix} h \\ x \end{bmatrix}$$

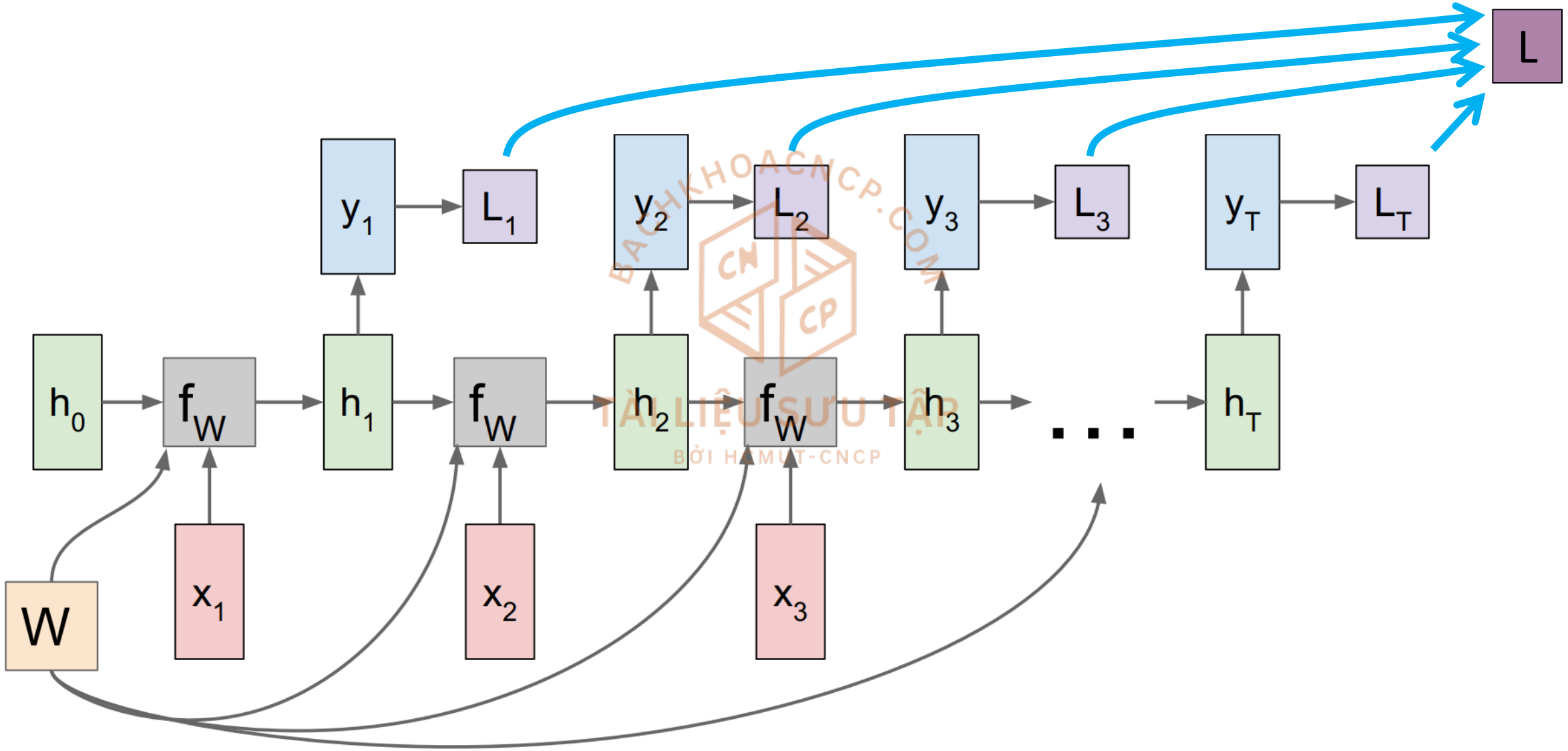
$$h_t = tanh(W_{hh}h_{t-1} + W_{xh}x_t + b_h)$$

Recurrent Neural Network

$$y_t = softmax(W_{hy}h_t + b_y)$$



Recurrent Neural Network



Recurrent Neural Network

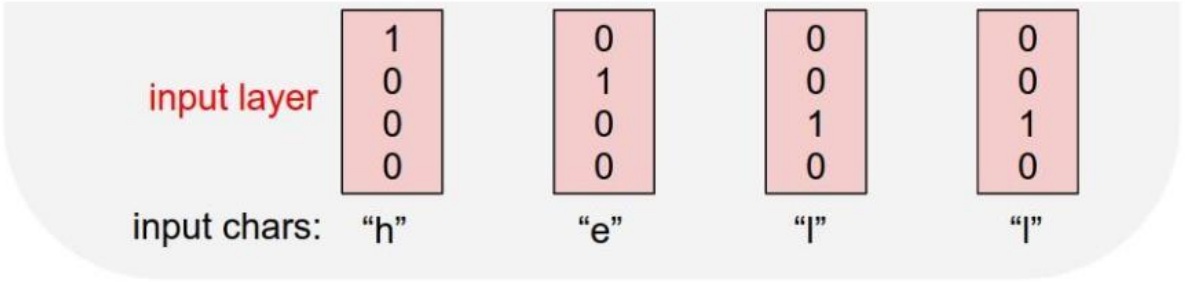
- Example: LSTM music composer
  - Example 1
    - 100 Epoch
    - 150 Epoch
  - Example 2

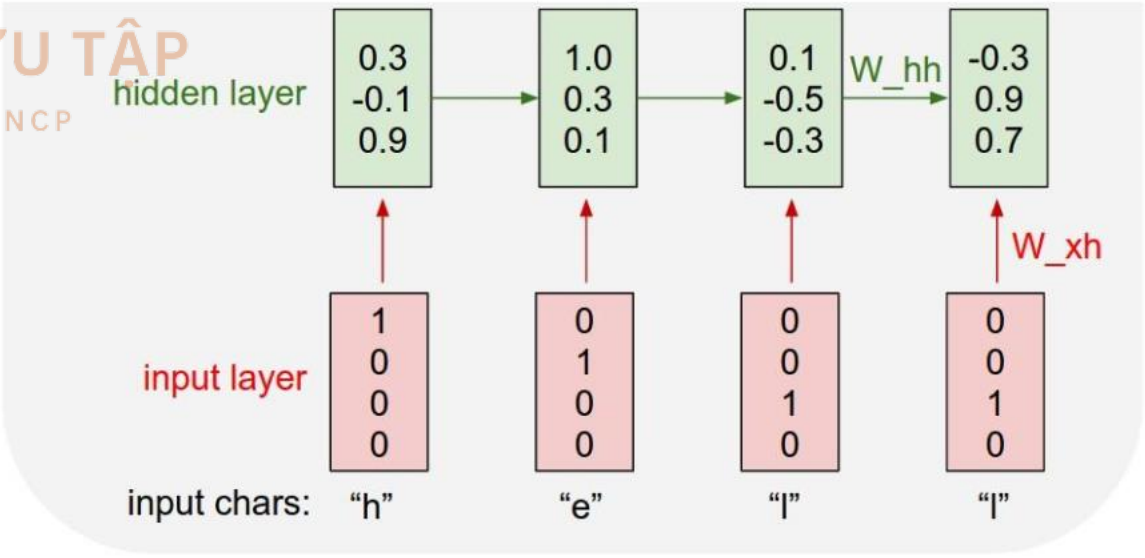
Recurrent Neural Network

- Example: Language model - Character level
  - Training sequence: “hello”
  - Vocabulary: h, e, l, o

$$h_t = tanh(W_{hh}h_{t-1} + W_{xh}x_t + b_h)$$

3x3 3x1 3x4 4x1 3x1



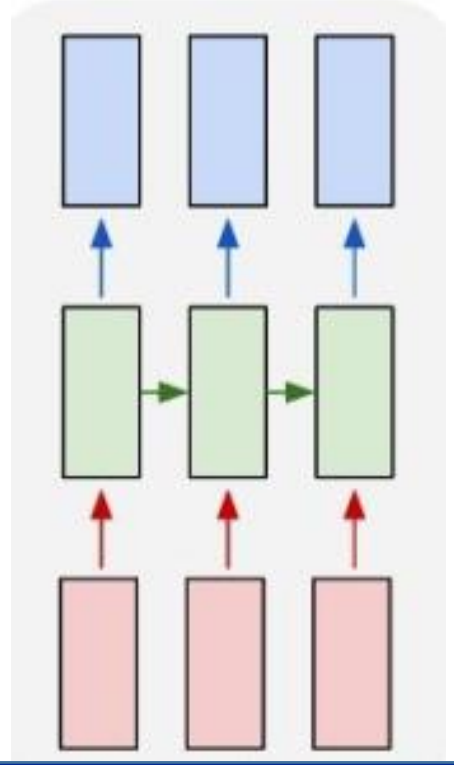


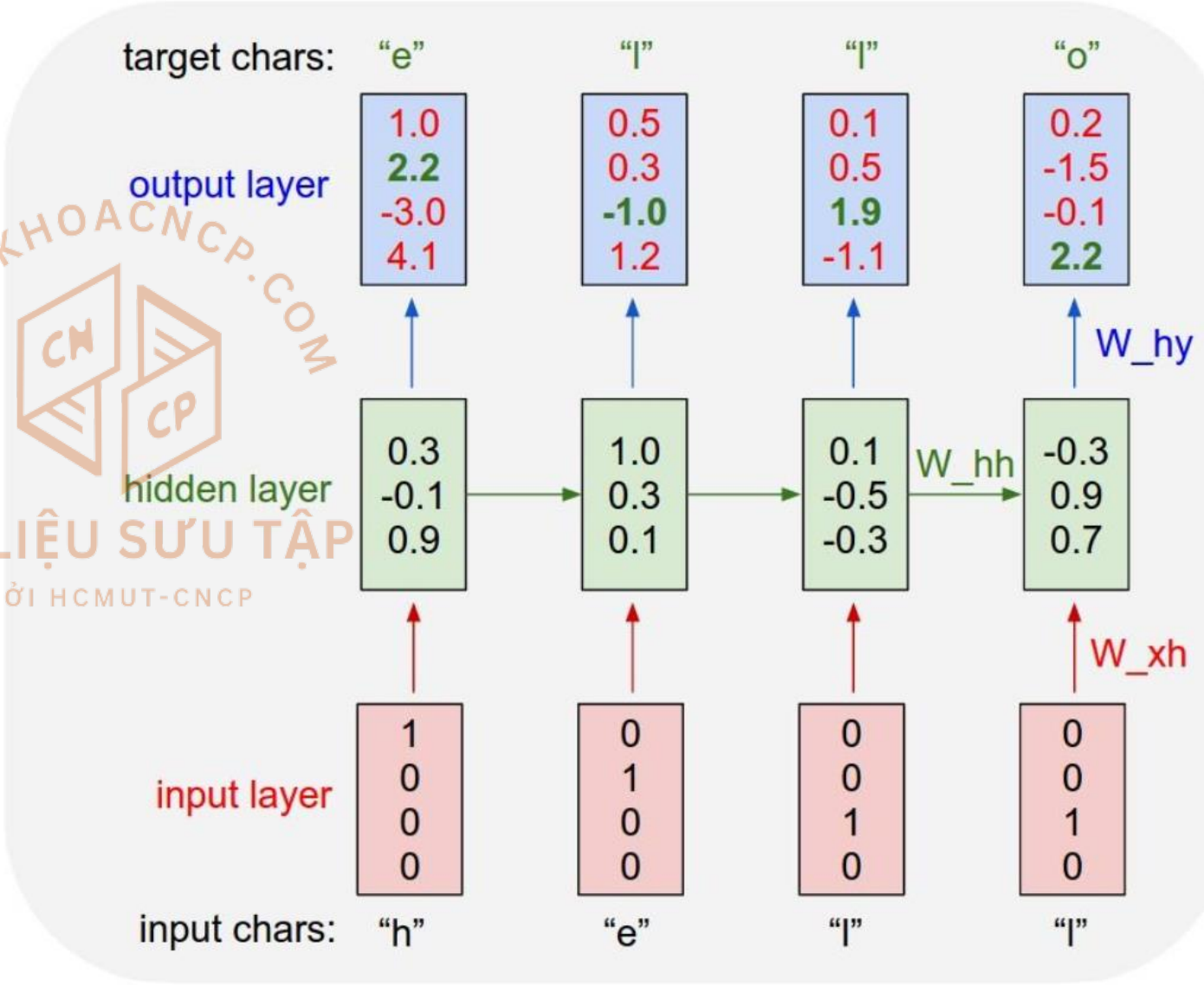
Recurrent Neural Network

$$y_t = softmax(W_{hy}h_t + b_y)$$

4x3 3x1 4x1

many to many





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